NPO: Ontology for Cancer Nanotechnology Research

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Abstract

We present the design and development of NanoParticle Ontology (NPO). The ontology is implemented in the Ontology Web Language (OWL). The domain terms in NPO currently represent entities, which describe knowledge about physical, chemical, and functional properties of nanoparticles characterized in cancer nanotechnology research. The upper-level of NPO is formed using terms from the Basic Formal Ontology (BFO).

Introduction

In cancer nanotechnology research, there are diverse types of nanoparticles being developed and tested for applications in cancer diagnostics and therapeutics (NP-CDTs). These nanoparticles are diverse in their chemical composition, properties and application. The chemical composition of these nanoparticles can be varied in many combinatorial ways, which result in the development of as many types of nanoparticles. Small variations in the chemical composition cause drastic changes in the physical, chemical and functional properties of nanoparticles. Experiments performed to characterize the properties of these nanoparticles generate large volumes and diverse types of data. To efficiently share and use this data, and to further the application of nanotechnology to cancer treatment, supports for a common vocabulary and informatics methods are required.

We have developed an ontology, called the **N**ano**P**article **O**ntology (NPO), to provide a common vocabulary and the knowledge framework for enabling interdisciplinary discourse, and annotation of NP-CDT data in order to facilitate the sharing and semantic integration of data for reuse, analysis and inferencing of the data.

Results

We developed the NPO using well-defined design principles in OWL. Public releases of NPO are available through BioPortal (http://bioportal.bioontology.org/virtual/1083). The current version (2009-06-04) of the NPO contains 919 terms and 21 associative relationships. The domain terms in the NPO were first obtained from the literature and other controlled vocabularies / ontologies (e.g., GO, ChEBI, NCI Thesaurus). These terms were organized into a taxonomic hierarchy starting with BFO terms at the upper-level of the NPO (see Figure 1). The domain terms represent different types of entities related to the description of NP-CDTs. These include entities which describe: (1) material entities that are synthesized, characterized and distinguished at the nanoscale (1-100 nm) size range; (2) material entities that are distinguished at the molecular structure level; (3) physical sites in a material entity; (4) surface of a material entity; (5) quality or property inhering in a material entity; (6) role of material entity at the molecular level; (7) type of stimulus for activating nanoparticle function, and response to stimulus; (8) tumor targeting methods; (9) functions of molecular entities that are realized as processes; (10) biological processes; and, (11) chemical linkages and interactions in a nanoparticle.

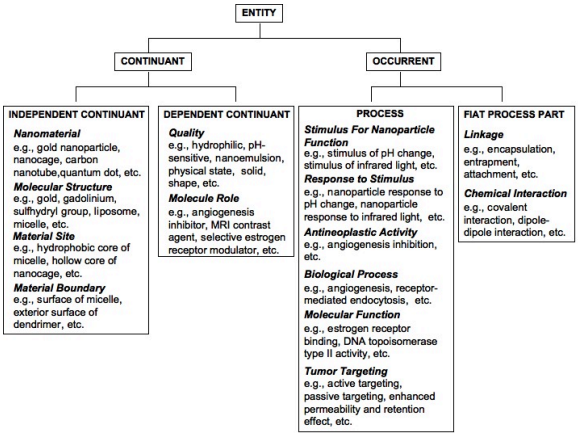

Figure 1. Example showing the BFO classification of domain terms

Conclusion and future directions

We have laid the foundation for future growth of NPO. Future work involves curation of existing terms and extension of NPO for supporting caNanoLab (http://gforge.nci.nih.gov/projects/calab/) database curation activities and data annotation.

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